DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, D.C. 20330

REPLY To
ATTN OF: LEED

17 Oct 1990

SUBJECT: Engineering Technical Letter (ETL) 90-10:
Commissioning of Heating Ventilating, and Air-Conditioning (HVAC) Systems Guide Specification

TO: See Distribution List

1. Purpose:

a. This ETL provides a guide specification (attachment 2) to use when specifying HVAC systems in facility construction projects. The purpose of commissioning is to bring the project's HVAC system to a state of dynamic operation in accordance with the contract plans and specifications by verifying the operation of individual components, subsystems, and systems before acceptance of the facility.

b. This ETL is authorized by AFR 8-7, Air Force Engineering Technical Letters (ETL) dated 9 Jan 86.

2. Effective Date: Immediately.

3. Referenced Publications:

a. AFR 88-15, Criteria and Standards for Air Force Construction.

b. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Guideline 1-1989, Guideline for Commissioning HVAC Systems.

4. Description/Implementation:

a. On all applicable projects worldwide, use this standard specification, modified as required, to ensure a technically correct specification in conformance with the drawings.

b. This specification contains specific notes. Read each note and modify this standard specification as required to ensure it is technically correct and well coordinated with the drawings.

DISTRIBUTION LIST

AIR FORCE

HQ AFMC/CEC (3)
4225 Logistics Ave
Wright-Patterson AFB OH 45433-5739

HQ AFRES/CEM (2)
155 2nd Street
Robins AFB GA 31098-1635

HQ AETC/CEM (3)
Bldg 661, 73 Main Circle
Randolph AFB TX 78150-4549

HQ PACAF/CEM (3)
25 E Street, Suite D-302
Hickam AFB HI 96853-5412

HQ USAFE/RSIO (3)
Unit 3050, Box 10
APO AE 09094-5010

CETSO/ESOF (1)
11817 Canon Boulevard, Suite 500
Crestar Bank Building
Newport News VA 23606-2558

HQ AMC/CES (3)
507 A Street
Scott AFB IL 62225-5001

HQ AFSPC/CEO (3)
150 Vandenberg Street, Suite 1105
Peterson AFB CO 80914-4150

SSC/SBEE (1)
201 East Moore Drive (Gunter Annex)
Maxwell AFB FL 36114-3005

NGB/CEP/CEO (1)
2500 Army Pentagon (2D369)
Washington DC 20331

HQ AIA/LEE (1)
102 Hall Boulevard, Suite 241
San Antonio TX 78243-7030

HQ AFCC/CEM (2)
203 W Losey Street, Rm 1020
Scott AFB IL 62225-5219

HQ AU/DEE (1)
400 Cannot Street
Maxwell AFB AL: 36112-6523

1100 NCR SPT GP/DOL (1)
1410 Air Force Pentagon (5E1078)
Washington DC 20330-1430

HQ USAFA/CEE (1)
8120 Edgerton Dr, Suite 40
USAF Academy CO 80840-2400

11 SPT GP/CEM (1)
1 McChord Street, Suite 208
Bolling AFB DC 20332-5109

AFIT/DEE (1)
2950 P Street
Wright-Patterson AFB OH 45433-7765

HQ ACC/CEM (3)
129 Andrews Street, Suite 346
Langley AFB VA 23665-2769

HQ AFSOC/CE (1)
100 Bartley Street, Suite 218E
Hurlburt Field FL 32544-5273

HQ USAF/CEC (1)
1260 Air Force Pentagon
Washington DC 20330-1260

ANGRC/CEE (1)
3500 Setchet Avenue, Bldg 3500
Andrews AFB MD 20331-5157

AFCEE/CM/DG (2)
8106 Chennault Road
Brooks AFB TX 78235-5318

7 CG/XPGF (1)
1600 Air Force Pentagon
Washington DC 20330-1600

HQ AFOTEC/DE (1)
8500 Gibson Boulevard SE
Kirtland AFB NM 87117-5558

HQ AFSVA/SVQF (1)
Randolph AFB TX 78150-6001

HQ AF Safety Agency/SEGS (1)
9700 G Avenue SE, Suite 240
Kirtland AFB TX 87117-5664

HQ AFOMS/SGS
Brooks AFB TX 78235-5000 (1)

HQ AF Inspection Agency/IGSE (1)
Norton AFB CA 92409-7001

ARMY

Chief of Engineers (2)
Department of the Army
Attn: CEMP-EA
20 Massachusetts Avenue
Washington DC 20314-1000

NAVY

LANTNAVFACENGCOM (1)
Code 04C
1510 Gilbert St
Norfolk VA 23511-2699

NORTHNAVENGCOM (1)
Code 406
10 Industrial Hwy
Mail Stop 82
Lester PA 19113-2090

SOUTHNAVFACENGCOM (1)
Code 406
Bldg 258 Makalapa
Pearl Harbor HI 96860-7300

SOUTHNAVFACENGCOM S(1)
Code 406 DPD
1255 Eagle Dr
North Charleston SC 29419-9010

WESTNAVFACENGCOM
Code 406
900 Commodore Dr
San Bruno CA 94066-2402

SOUTHWESTNAVFACENGCOM (1)
Code 406
1220 Pacific Hwy Bldg 130
San Diego CA 92132-5188

DISTRIBUTION LIST (Continued)

ENGFLDACT Chesapeake (1)
Code 406
901 M St SE Bldg 212 WNY
Washington DC 20374-5018

ENGFLDACT MED (1)
Code N4
PSC 810 Box 51
FPO AE 09619-9951

ENGFLDACT NW (1)
Code 04B
3505 NW Anderson Hill Rd
Silverdale WA 98383-2366

ENGFLDACT MW (1)
Code 420
Bldg 1A
Great Lakes IL 60088-5600

DEPARTMENT OF DEFENSE

Defense Commissary Services (1)
Director of Facilities
Bldg 8400
Lackland AFB TX 78236-5000

Defense Technical Information (1)
Center
ATTN: DTIC-FDA
Alexandria VA 22034-6145

AAFES/ATTN: CFE (1)
PO Box 660320
Dallas TX 75266-0320

SPECIAL INTEREST ORGANIZATIONS

IHS (A.A. DeSimone) (1)
1990 M Street NW, Suite 400
Washington DC 20036

Construction Criteria Database (1)
National Institute of Bldg. Sciences
1201 L Street NW, Suite 400
Washington, D.C. 20005

ENGINEERING TECHNICAL LETTERS (ETL)

SECTION A - CURRENT ETLs

ETL Number	Title	Date Issued
88-2	Photovoltaic Applications	21 Jan 88
88-3	Design Standards for Critical Facilities	15 Jun 88
88-4	Reliability & Maintainability (R&M) Design Checklist	24 Jun 88
88-5	Cathodic Protection	2 Aug 88
88-6	Heat Distribution Systems Outside of Buildings	1 Aug 88
88-7	TEMPEST & High Altitude Electromagnetic Pulse (HEMP) Protection For Facilities	24 Aug 88
88-8	Chlorofluorcarbon (CFC) Limitation in Heating, Ventilating, and Air-Conditioning (HVAC) Systems	4 Oct 88
88-9	Radon Reduction in New Facility Construction	7 Oct 88
88-10	Prewired Workstations Guide Specification	29 Dec 88
89-1	1988 Energy Prices and Discount Factors For Life-Cycle Cost Analysis	6 Feb 89
89-2	Standard Guidelines for Submission of Facility Operating and Maintenance Manuals	23 May 89
89-3	Facility Fire Protection Criteria for Electronic Equipment Installations	9 Jun 89
89-4	Systems Furniture Guide Specification	6 Jul 89
89-5	Air Force Interior Design Policy not yet	
89-6	Power Conditioning and Continuation Interfacing Equipment (PCCIE) in the Military Construction Program (MCP)	7 Sep 89
89-7	Design of Air Force Courtrooms	29 Sep 89
90-1	Built-Up Roof (BUR) Repair/Replacement Guide Specification	23 Jan 90
90-2	General Policy for Prewired Workstations and Systems Furniture	26 Jan 90
90-3	TEMPEST Protection for Facilities	23 Mar 90
90-4	1990 Energy Prices and Discount Factors for Life-Cycle Cost Analysis	24 May 90
90-5	Fuel and Lube Oil Bulk Storage Capacity for Emergency Generators	26 Jul 90

SECTION B - OBSOLETE ETLs

No.	Date	Status
82-1	10 Nov 82	Superseded by ETL 83-10, 86-1, 87-4
82-3	10 Nov 82	Superseded by ETL 83-5, 84-2
82-4	10 Nov 82	Superseded by ETL 84-7
82-5	10 Nov 82	Superseded by ETL 84-1, 86-13, 86-14
82-6	30 Dec 82	Cancelled
82-7	30 Nov 82	Cancelled
83-2	16 Feb 83	Superseded by ETL 84-3
83-6	24 May 83	Cancelled
84-3	21 Mar 84	Cancelled
84-4	10 Apr 84	Superseded by ETL 86-7, 86-15, 87-5
84-5	7 May 84	Superseded by ETL 84-8, 86-11, 86-18, 88-6
84-6	Not Issued	Cancelled/Not Used
84-9	5 Jul 84	Superseded by ETL 88-7
86-3	21 Feb 86	Superseded by ETL 86-4
86-6	3 Jun 86	Superseded by ETL 86-11, 86-18, 88-6
86-7	3 Jun 86	Superseded by ETL 86-15
86-12	3 Jul 86	Superseded by ETL 90-2
86-13	18 Aug 86	Superseded by ETL 86-14
86-15	13 Nov 86	Superseded by ETL 87-5
86-17	17 Dec 86	Superseded by ETL 89-6
86-18	18 Dec 86	Superseded by ETL 88-6
87-3	12 Mar 87	Superseded by ETL 87-6, 88-5
87-6	21 Aug 87	Superseded by ETL 88-5
87-7	14 Oct 87	Superseded by ETL 89-1
Change 1	30 Dec 87	Superseded by ETL 89-1
87-8	19 Oct 86	Superseded by ETL 90-1
88-1	5 Jan 88	Superseded by ETL 89-2

17 October 1990

ENGINEERING TECHNICAL LETTER (90-09):

COMMISSIONING OF HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC) SYSTEMS GUIDE SPECIFICATION

JOB_____

LOCATION_____

NOTE: (1) Prior to marking up this section, SPECIFICATION WRITERS SHALL CAREFULLY REVIEW ALL "NOTES" contained at the front of this section.

(2) WHEN SUBMITTING "DRAFT" SPECIFICATION FOR REVIEW, THIS COVER SHEET AND THE FOLLOWING "NOTES TO SPECIFICATION WRITER" SHALL REMAIN ATTACHED.

(3) The SUBMITTAL REGISTER attached at the end of this section must be edited and finalized to match the completed project specification.

SPECIFICATION WRITER_____DATE_____

REVIEWED BY_____DATE_____

NOTES TO SPECIFICATION WRITER

1. The specification writer is required to read all the notes and modify this guide specification as required to insure a technically correct specification, well coordinated with the drawings.

2. This guide specification is to be used in the preparation of contract specifications and will not be made a part of a contract merely by reference; therefore, pertinent portions will be copied verbatim into the contract documents.

3. Where numbers, symbols, words, phrases, clauses, or sentences in this specification are enclosed in brackets [], a choice or modification must be made; delete inapplicable portion(s) carefully. Where blank spaces occur in sentences, insert the appropriate data. Where entire paragraphs are not applicable they should be deleted completely.

4. The designer shall incorporate in the drawings and other sections of the contract specifications all calibrated balancing valves, filter manometers, etc. required to perform the commissioning indicated in this section of the specifications.

5. Paragraph 5: The designer shall provide a pre-commissioning checklist for each system component included in the project. If more than one component of each type is utilized, then duplicates of that pre-commissioning checklist shall be made and included in this section of the specifications. For example, if two air handlers are used, two pre-commissioning checklists would be included in the specifications. Each checklist will have the drawing symbol (AHU-1, AHU-2, etc.) at the top as indicated and will be numbered consecutively. If there is no standard checklist for an item of equipment in the project, the designer should formulate a checklist and include it in the specifications.

6. Paragraph 6: The designer shall provide a functional performance test checklist for each system component included in the project. If more than one component of each type is utilized, then duplicates of that functional performance test checklist shall be made and included in this section of the specifications. If there is no standard checklist for an item of equipment in the project, the designer should formulate a checklist and include it in the specifications.

COMMISSIONING HVAC SYSTEMS

Index

1. GENERAL REQUIREMENTS: This specification covers the commissioning of HVAC systems which are a part of this project. The purpose of commissioning is to bring the project HVAC system to a state of dynamic operation in accordance with the contract plans specifications by verifying the operation of individual components, subsystems, and systems.

1.1 Tools and Equipment: The Contractor shall furnish all special tools and equipment required during the commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted for approval. The government will furnish necessary utilities for the commissioning process.

2. COMMISSIONING DOCUMENTATION: The Contractor shall maintain the commissioning documentation in ring binders. The commissioning documentation shall be organized by system and subsystem when practicable. All pages shall be numbered and a table of contents page shall be provided. The commissioning documentation shall include, but not be limited to, the following.

a. Approved Test and Balance Report for the building (project) being commissioned.

b. All approved shop drawings of HVAC equipment to be commissioned. Shop drawings shall be full size sheets folded as required to fit in binders.

c. All pre-commissioning checklists initialed by indicated personnel organized by system and subsystem.

d. All functional performance test checklists signed by indicated personnel organized by system and subsystem.

e. Three copies of the Operation and Maintenance Manuals specified on other sections of these specifications shall be included with the Commissioning Documentation. The manuals shall be incorporated in the Commissioning Documentation prior to the commencement of the training required in this and other sections of the specifications. Preparation of Operation and Maintenance Manuals shall be as specified in other sections of these specifications.

2.1 HVAC Shop Drawings and As Built Drawings and Specifications shall be assembled after completion of HVAC pre-commissioning phase and prepared as indicated above. Changes as a result of subsequent HVAC Commissioning procedures will be incorporated (as required) at the conclusion of final HVAC Commissioning.

2.2 The Contractor shall be responsible for maintaining the commissioning documentation until final acceptance of the project. All checklists included in this section of the specifications shall become part of the commissioning documentation. The commissioning documentation shall be kept current by the contractor and shall be available for inspection at all times. At the time of acceptance of the project, the Contractor shall furnish 3 copies of the commissioning documentation to the Contracting Officer.

3. COMMISSIONING SCHEDULE:

3.1 Phase 1 - Preliminary Commissioning: All HVAC shop drawings, including but not limited to equipment, controls, test and balance reports, operation and maintenance manuals, shall be submitted and approved by the Contracting Officer. In addition, all pre-commissioning checklists shall be completed (initialed by all parties).

3.2 Phase 2 - Functional Performance Testing shall be performed as indicated on the Functional Performance Test Checklists. Functional Performance Testing shall not begin until Phase 1 of the commissioning process is complete.

3.2.1 Functional Performance Test Notification: The Contractor shall notify the Contracting Officer 2 weeks before functional performance testing is to begin.

3.3 Phase 3 - HVAC Training shall be conducted as indicated in the specifications for each item of equipment.

4. SYSTEM PERFORMANCE CRITERIA: All HVAC related equipment commissioned in this section of the specifications will be evaluated based on the sequences of operation/control and the equipment schedules. Sequences of equipment operation and control and design performance data shall be as specified for the equipment item in other sections of these specifications and on the contract drawings.

5. PRE-COMMISSIONING CHECKLISTS:

5.1 Pre-commissioning checklists shall be completed prior to the commencement of functional performance testing. The indicated initial is required in each location for all items, except where an "X" is shown indicating an initial is not required. See initials legend below for required initials. The pre-commissioning checklist will not be accepted as complete until all items have been initialed signifying this portion of the project is ready for Functional Performance Testing. The Contracting Officer's representative shall be the last person to initial each checklist item. The Contractor shall submit for approval a list of all Contractor and subcontractor representatives responsible for the completion of the pre-commissioning checklist phase of the project. This list of representatives shall be submitted 2 weeks prior to the installation of any HVAC equipment. Representatives may be replaced only after written approval from the Contracting Officer.

5.1.1 Initials Legend:

A - General Contractor's representative.
B - Mechanical Contractor's representative.
C - Electrical Contractor's representative.
D - Contracting Officer's representative.
E - Balancing Contractor's representative.
F - Controls Contractor's representative.

5.2 Blank pre-commissioning checklists are in Appendix 1 located at the end of this section of the specifications.

6. FUNCTIONAL PERFORMANCE TEST CHECKLIST:

6.1 Functional performance testing shall be performed by a commissioning team consisting of the individuals indicated on the Functional Performance Test Checklists. The Contractor shall submit in writing a list of all Contractor and subcontractor representatives responsible for the completion of the functional performance testing phase of the project. This list of representatives shall be submitted 2 weeks prior to commencement of functional performance testing of HVAC equipment. All representatives shall remain on the commissioning team throughout functional performance testing. Substitutions will not be permitted. Functional performance test checklists shall be completed in the presence of all commissioning team personnel at the time of the functional performance test.

6.1.1 Upon failure of completion of a functional performance test checklist, the contractor shall provide a written report to the contracting officer listing the deficiencies causing the failure and remedies to correct all deficiencies. After the contractor has corrected all deficiencies, the entire functional performance test checklist for the item of equipment shall be repeated. If possible, corrections can be accomplished during the functional performance testing of equipment in other non-related systems. In any case, no system will be accepted until all equipment items in the system have complete functional performance test checklists thereby demonstrating satisfactory performance.

6.1.2 Failure to complete 3 functional performance test checklists constitutes failure of phase 2 of the HVAC commissioning process, however functional performance testing shall be continued to identify all failures. The Contractor shall provide a written report to the Contracting Officer listing the deficiencies causing all failures and remedies to correct all deficiencies. After correction of all deficiencies, phase 2 of the HVAC commissioning process shall be repeated in its entirety. The Contractor shall give the Contracting Officer 2 weeks notice before repeat functional performance testing is scheduled.

6.1.2.1 In the event of a failure of the functional performance testing phase of the commissioning process as defined herein, the Contractor will be assessed charges to acquire Government personnel back on site for retesting observation. See SPECIAL CLAUSE paragraph entitled: HVAC COMMISSIONING FUNCTIONAL PERFORMANCE TESTING.

6.2 Blank functional performance test checklists are in Appendix 2 located at the end of this section of the specifications.

7. QUALITY CONTROL:

7.1 General: The Contractor shall establish and maintain quality control for operations under this section to assure compliance with contract requirements and maintain records of his quality control for all the activities listed herein before. A complete quality control report shall be made of each of the activities outlined in this section of the specifications listing attendees, items discussed, deficiencies noted and corrective actions taken. The quality control reports for this section shall be made in duplicate so that one copy can be transmitted through quality control channels and the other made a part of the commissioning documentation.

PARAGRAPH NUMBER	DESCRIPTION OF SUBMITTAL	TYPE OF SUBMITTAL (*)							TECH REVIEW BY
		1	2	3	4	5	6	7	
1.1	List of all tools and equipment							X	CD/OD-A
2.2	Commissioning Documentation							X	CD/OD-I
3.1	HVAC shop drawings, equipment, controls, test and balance reports, operation and maintenance manuals	X					X	X	ED-A
5.1 & 6.1	Contractor and Subcontractor representatives							X X	CD/OD-A
6.1.2	Deficiencies and remedies report							X	CD/OD-I
7.1	Quality Control report							X	CD/OD-I

(*) 1 = Shop Drawings
2 = Sample
3 = Guarantee
4 = Mfr's Data
5 = Certificate
6 = Test Report
7 = Other As Noted

CD/OD = Constr. Div. or Ops. Div.
ED = Engr. Div.
A = For Approval
I = For Information

APPENDIX 1
PRE-COMMISSIONING CHECKLISTS

1. PRE-COMMISSIONING CHECKLIST - DUCTWORK

For Air Handler:_____ [fill in air handler symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Ductwork complete.	___	___	X	___	___	X
b. As-built shop drawings submitted.	___	___	X	___	___	X
c. Duct pressure and leakage test complete.	___	___	X	___	___	X
d. Fire dampers installed as required.	___	___	X	___	___	X
e. Smoke dampers installed as required.	___	___	X	___	___	___
f. Access doors and panels installed.	___	___	X	___	___	X
g. Verify open/closed status of dampers.	___	___	X	___	___	___
h. Verify Smoke dampers operation.	___	___	X	___	___	___
Test and Balance						
a. Test and Balance operation complete.	___	___	X	___	___	___

2. PRE-COMMISSIONING CHECKLIST - MULTIZONE AIR HANDLING UNIT

For Air Handling Unit:_____ [fill in air handling unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Vibration isolation devices installed.	——	——	X	——	X	X
b. Access doors are operable and sealed.	——	——	X	——	——	X
c. Casing undamaged.	——	——	X	——	X	X
d. Insulation undamaged.	——	——	X	——	X	X
e. Condensate drainage is unobstructed.	——	——	X	——	X	X
f. Fan belt adjusted.	——	——	X	——	——	X
Electrical						
a. Power available to unit disconnect.	——	——	——	——	X	——
b. Power available to unit control panel.	——	——	——	——	X	——
c. Power available to electric heating coil.	——	——	——	——	X	——
d. Proper motor rotation verified.	——	——	——	——	——	X
Coils						
a. Chilled water piping properly connected.	——	——	X	——	——	——
b. Chilled water piping pressure tested.	——	——	——	——	X	X
[a. Refrigerant piping properly connected.	——	——	X	——	X	X]
[b. Refrigerant piping pressure tested.	——	——	X	——	X	X]
c. Hot water piping properly connected.	——	——	X	——	——	——
d. Hot water piping pressure tested.	——	——	X	——	X	X
[c. Steam piping properly connected.	——	——	X	——	X	]
[d. Steam piping pressure tested.	——	——	X	——	X	X]

2. PRE-COMMISSIONING CHECKLIST - MULTIZONE AIR HANDLING UNIT

For Air Handling Unit:_____ [fill in air handling unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Controls						
a. Control valves/actuators properly installed.	___	___	X	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___
c. O.A. Dampers/actuators properly installed.	___	___	X	___	___	___
d. O.A. Dampers/actuators operable.	___	___	X	___	___	___
e. Zone Dampers/actuators properly installed.	___	___	X	___	___	___
f. Zone Dampers/actuators operable.	___	___	X	___	___	___
Test and Balance (T&B)						
a. Construction filters removed and replaced.	___	___	X	___	___	X
b. T&B simulate 1/2 loaded filters.	___	___	X	___	___	X
c. T&B results +/- 10% cfm shown on drawings.	___	___	X	___	___	X
d. Test and Balance Report submitted.	___	___	X	___	___	X

3. PRE-COMMISSIONING CHECKLIST - VARIABLE VOLUME AIR HANDLING UNIT

For Air Handling Unit:_____ [fill in air handling unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Vibration isolation devices installed.	——	——	X	——	X	X
b. Access doors are operable and sealed.	——	——	X	——	——	X
c. Casing undamaged.	——	——	X	——	X	X
d. Insulation undamaged.	——	——	X	——	X	X
e. Condensate drainage is unobstructed.	——	——	X	——	X	X
f. Fan belt adjusted.	——	——	X	——	——	X
2. Electrical						
a. Power available to unit disconnect.	——	——	——	——	X	X
b. Power available to unit control panel.	——	——	——	——	X	——
c. Power available to electric heating coil.	——	——	——	——	X	X
d. Proper motor rotation verified.	——	——	——	——	——	X
Coils						
a. Chilled water piping properly connected.	——	——	X	——	——	——
b. Chilled water piping pressure tested.	——	——	X	——	X	——
[a. Refrigerant piping properly connected.	——	——	X	——	X	X]
[b. Refrigerant piping pressure tested.	——	——	X	——	X	X]
c. Hot water piping properly connected.	——	——	X	——	——	——
d. Hot water piping pressure tested.	——	——	——	——	X	X
[c. Steam piping properly connected.	——	——	X	——	——	]
[d. Steam piping pressure tested.	——	——	X	——	——	]

3. PRE-COMMISSIONING CHECKLIST - VARIABLE VOLUME AIR HANDLING UNIT

For Air Handling Unit:_____ [fill in air handling unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
Controls						
a. Control valves/actuators properly installed.	___	___	X	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___
e. Duct static pressure sensor installed.	___	___	X	___	___	___
f. Static pressure sensor calibrated.	___	___	X	___	___	___
g. Fan air volume controller operable.	___	___	X	___	___	___
h. Air handler controls system operational.	___	___	X	___	___	___
Test and Balance (T&B)						
a. Construction filters removed and replaced.	___	___	X	___	___	___
b. T&B simulate 1/2 loaded filters.	___	___	X	___	___	X
c. T&B results +/- 10% cfm shown on drawings.	___	___	X	___	___	X
d. Test and Balance Report submitted.	___	___	X	___	___	X

4. PRE-COMMISSIONING CHECKLIST - VAV TERMINAL

For VAV Terminal:_____ [fill in VAV Terminal symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. VAV terminal in place.	——	——	X	——	X	X
b. VAV terminal ducted.	——	——	X	——	X	X
c. VAV terminal connected to controls.	——	——	X	——	X	——
d. Re-heat coil connected to hot water pipe.	——	——	X	——	——	X
e. Electric Re-heat coil connected to local disconnect.	——	——	——	——	——	X
Controls						
a. Cooling only VAV terminal controls set.	——	——	X	——	X	——
b. Cooling only VAV controls verified.	——	——	X	——	X	——
c. Re-heat VAV terminal controls set.	——	——	X	——	X	——
d. Re-heat terminal/coil controls verified.	——	——	X	——	X	——
Test and Balance						
a. Verify terminal maximum air flow set.	——	——	X	——	——	——
b. Verify terminal minimum air flow set.	——	——	X	——	——	——
c. Low pressure duct balanced at maximum flow.	——	——	X	——	——	X
d. Test and Balance operation complete.	——	——	X	——	——	X

5. PRE-COMMISSIONING CHECKLIST - DX AIR COOLED CONDENSING UNIT

For Condensing Unit:_____ [fill in condensing unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Condensing Unit in place with recommended service/air clearances.	——	——	X	——	X	X
b. Condensing Unit piped.	——	——	X	——	X	X
c. Refrigerant pipe leak tested.	——	——	X	——	X	X
Electrical						
a. Power available to unit disconnect.	——	——	——	——	X	X
b. Power available to unit control panel.	——	——	——	——	X	——
Controls						
a. Unit safety/protection devices tested.	——	——	X	——	X	——
b. Control system and interlocks installed.	——	——	X	——	X	——
c. Control system and interlocks operational.	——	——	X	——	X	——

6. PRE-COMMISSIONING CHECKLIST - PUMPS

For Pump:_____ [fill in pump symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Pumps grouted in place.	—	—	X	—	X	X
b. Pump vibration isolation devices functional.	—	—	X	—	X	X
c. Pump alignment verified.	—	—	X	—	X	X
d. Piping system installed.	—	—	X	—	X	X
e. Piping system pressure tested.	—	—	X	—	X	X
f. Pump not leaking.	—	—	X	—	X	X
Electrical						
a. Power available to pump disconnect.	—	—	—	—	X	X
b. Pump rotation verified.	—	—	—	—	X	X
c. Control system interlocks functional.	—	—	—	—	X	—
Test & Balance						
a. Pressure/temperature gauges installed.	—	—	X	—	—	X
b. Piping system cleaned.	—	—	X	—	X	X
c. Chemical water treatment complete.	—	—	X	—	X	X
d. Water balance complete.	—	—	X	—	—	X
e. Water balance with design maximum flow.	—	—	X	—	—	X
f. Test and Balance Report submitted.	—	—	X	—	—	X
Related Pre-Commissioning checklists completed						
a. Chiller.	—	—	—	—	—	—
b. Cooling Tower.	—	—	—	—	—	—
c. Boiler.	—	—	—	—	—	—

7. PRE-COMMISSIONING CHECKLIST - PACKAGED AIR COOLED CHILLER

For Chiller:_____ [fill in chiller symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Chiller manufacturer's clearances provided.	___	___	X	___	X	X
b. Chiller properly piped.	___	___	X	___	___	___
c. Chilled water pipe leak tested.	___	___	X	___	X	X
Electrical						
a. Power available to unit disconnect.	___	___	___	___	X	___
b. Power available to unit control panel.	___	___	___	___	X	___
c. Separate power to electric heating tape.	___	___	___	___	X	___
Controls						
a. Factory start-up and check out complete.	___	___	X	___	X	___
b. Chiller safety/protection devices tested.	___	___	X	___	X	___
c. Chilled water flow switch installed.	___	___	X	___	X	___
d. Chilled water flow switch tested.	___	___	X	___	X	___
e. Chilled water pump interlock installed.	___	___	X	___	X	X
f. Chilled water pump interlock tested.	___	___	___	___	X	___
Related Pre-Commissioning checklists completed:						
a. Chilled water pumps.	___	___	___	___	___	___
b. Test and Balance Report submitted.	___	___	X	___	___	X

8. PRE-COMMISSIONING CHECKLIST - CENTRIFUGAL CHILLER

For Chiller:_____ [fill in chiller symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Chiller manufacturer's clearances provided.	___	___	X	___	X	___
b. Chilled water connections properly piped.	___	___	X	___	___	___
c. Condenser water connections properly piped.	___	___	X	___	___	___
d. Chilled water pipe leak tested.	___	___	X	___	X	X
e. Condenser water pipe leak tested.	___	___	X	___	X	X
Electrical						
a. Power available to unit starter.	___	___	___	___	X	___
b. Power available to unit control panel.	___	___	___	___	X	___
Controls						
a. Factory start-up and check out complete.	___	___	X	___	X	___
b. Chiller safety/protection devices tested.	___	___	___	___	X	___
c. Chilled water flow switch installed.	___	___	X	___	X	___
d. Chilled water flow switch tested.	___	___	X	___	X	___
e. Chilled water pump interlock installed.	___	___	___	___	X	___
f. Chilled water pump interlock tested.	___	___	___	___	X	___
g. Condenser water flow switch installed.	___	___	X	___	___	___
h. Condenser water flow switch tested.	___	___	___	___	X	___
i. Condenser water pump interlock installed.	___	___	___	___	X	___
j. Condenser water pump interlock tested.	___	___	___	___	X	___

8. PRE-COMMISSIONING CHECKLIST - CENTRIFUGAL CHILLER

For Chiller:_____ [fill in chiller symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Related Pre-Commissioning checklists completed:						
a. Chilled water pumps.	___	___	___	___	___	___
b. Condenser water pumps.	___	___	___	___	___	___
c. Cooling Tower.	___	___	___	___	___	___
d. Test and Balance Report submitted.	___	X	___	___	___	___

9. PRE-COMMISSIONING CHECKLIST - COOLING TOWER

For Cooling Tower:_____ [fill in cooling tower symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Cooling Tower in place.	——	——	X	——	——	——
b. Cooling Tower piped.	——	——	X	——	X	——
c. Cooling Tower fan drive adjusted.	——	——	——	——	——	X
d. Cooling Tower makeup water supply piped.	——	——	X	——	X	——
e. Verify makeup control valve shut-off.	——	——	X	——	——	X
f. Fan lubricated and blade pitch adjusted.	——	——	X	——	——	X
Electrical						
a. Power available to Tower disconnect.	——	——	——	——	X	——
b. Power available to electric sump heater.	——	——	——	——	X	——
c. Control system interlocks functional.	——	——	——	——	X	——
d. Motor and fan rotation checked.	——	——	——	——	X	——
Piping						
a. Tower basin is clean and filled.	——	——	X	——	X	X
b. Condenser water treatment functional.	——	——	X	——	X	X
c. Water balance with design flow verified.	——	——	X	——	——	X
d. Water distribution headers balanced.	——	——	X	——	——	X

10. PRE-COMMISSIONING CHECKLIST - HOT WATER BOILER

For Boiler:_____ [fill in boiler symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Boiler installed with service clearances	——	——	X	——	——	——
b. Boiler flue installed.	——	——	X	——	——	——
c. Boiler hot water piping installed.	——	——	X	——	——	——
d. Boiler hot water piping tested.	——	——	X	——	X	——
e. Boiler makeup water piping installed.	——	——	X	——	——	——
f. Boiler fuel oil piping installed.	——	——	X	——	X	X
g. Boiler fuel oil piping tested.	——	——	X	——	X	X
h. Boiler gas piping installed.	——	——	X	——	X	X
i. Boiler gas piping tested.	——	——	X	——	X	X
Start-up						
a. Boiler system cleaned and filled.	——	——	X	——	——	——
b. Boiler safety/protection devices tested.	——	——	——	——	X	——
c. Boiler water treatment system functional.	——	——	X	——	X	——
d. Boiler start-up and check out complete.	——	——	X	——	X	——
Controls						
a. Hot water pump interlock installed.	——	——	——	——	X	——
b. Hot water pump interlock tested.	——	——	——	——	X	——
c. Hot water heating system balanced.	——	——	X	——	X	——
d. Hot water heating controls operational.	——	——	X	——	X	——
Related Pre-Commissioning checklists completed:						
a. Hot water pumps.	——	——	——	——	——	——
b. Test and Balance Report submitted.	——	——	X	——	——	——

11. PRE-COMMISSIONING CHECKLIST - STEAM BOILER

For Boiler:_____ [fill in boiler symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Boiler installed with service clearances.	—	—	X	—	X	X
b. Boiler flue installed.	—	—	X	—	X	X
c. Boiler steam piping installed.	—	—	X	—	X	X
d. Boiler steam piping tested.	—	—	X	—	X	X
e. Boiler makeup water piping installed.	—	—	X	—	—	X
f. Boiler makeup water piping tested.	—	—	X	—	X	X
g. Boiler fuel oil piping installed.	—	—	X	—	X	X
h. Boiler fuel oil piping tested.	—	—	X	—	X	X
i. Boiler gas piping installed.	—	—	X	—	X	X
j. Boiler gas piping tested.	—	—	X	—	X	X
Start-up						
a. Boiler system cleaned and filled.	—	—	X	—	X	X
b. Boiler safety/protection devices tested.	—	—	—	—	X	—
c. Boiler feed water system operational.	—	—	—	—	X	—
d. Boiler water treatment system functional.	—	—	X	—	X	X
e. Boiler start-up and check out complete.	—	—	—	—	X	—
f. All steam traps operational.	—	—	X	—	X	X
g. All condensate return pumps operational.	—	—	—	—	—	X
The following Pre-Commissioning checklists completed:						
a. Test and Balance Report submitted.	—	—	X	—	—	X

12. PRE-COMMISSIONING CHECKLIST - STEAM/HOT WATER CONVERTER

For Converter:_____ [fill in Converter symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Converter installed with service clearances.	___	___	X	___	X	X
b. Converter steam piping installed.	___	___	X	___	___	X
c. Converter steam piping tested.	___	___	X	___	X	X
d. Hot water piping installed.	___	___	X	___	___	___
e. Hot water piping tested.	___	___	X	___	X	X
f. Makeup water piping installed.	___	___	X	___	X	X
Start-Up						
a. Hot water system cleaned and filled.	___	___	X	___	X	X
b. All steam traps operational.	___	___	X	___	X	X
c. All condensate return pumps operational.	___	___	___	___	X	___
d. Converter safety/protection devices tested.	___	___	X	___	X	X
e. Converter start-up and check out complete.	___	___	X	___	X	X
Controls						
a. Control valves/actuators properly installed.	___	___	X	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___
The following Pre-Commissioning checklists completed:						
a. Test and Balance Report submitted.	___	___	X	___	___	___

13. PRE-COMMISSIONING CHECKLIST - FAN COIL UNIT

For Fan Coil Unit:_____ [fill in fan coil unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Vibration isolation devices installed.	——	——	X	——	X	X
b. Access doors are operable and sealed.	——	——	X	——	——	X
c. Casing undamaged.	——	——	X	——	X	X
d. Insulation undamaged.	——	——	X	——	X	X
e. Condensate drainage is unobstructed.	——	——	X	——	X	X
f. Fan belt adjusted.	——	——	X	——	——	X
Electrical						
a. Power available to unit disconnect.	——	——	——	——	X	——
b. Power available to unit control panel.	——	——	——	——	X	——
c. Power available to electric heating coil.	——	——	——	——	X	X
d. Proper motor rotation verified.	——	——	——	——	——	X
Coils						
a. Dual Temperature piping properly connected.	——	——	X	——	——	——
b. Dual Temperature piping pressure tested.	——	——	X	——	X	X
[a. Chilled water piping properly connected.	——	——	X	——	——	]
[b. Chilled water piping pressure tested.	——	——	X	——	X	X]
[c. Hot water piping properly connected.	——	——	X	——	——	]
[d. Hot water piping pressure tested.	——	——	X	——	——	]

13. PRE-COMMISSIONING CHECKLIST - FAN COIL UNIT

For Fan Coil Unit:_____ [fill in fan coil unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Controls						
a. Control valves/actuators properly installed.	___	___	X	___	___	___
b. Control valves/actuators operable.	___	___	X	___	X	___
Test and Balance (T&B)						
a. Construction filters removed and replaced.	___	___	X	___	___	___
b. T&B simulate 1/2 loaded filters.	___	___	X	___	___	X
c. T&B results +/- 10% cfm shown on drawings.	___	___	X	___	___	X
d. Test and Balance Report submitted.	___	___	X	___	___	X

14. PRE-COMMISSIONING CHECKLIST - UNIT HEATER

For Unit Heater:_____ [fill in unit beater symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Hot water piping properly connected.	——	——	X	——	——	——
b. Hot water piping pressure tested.	——	——	X	——	X	X
[a. Steam piping properly connected.	——	——	X	——	——	——]
[b. Steam piping pressure tested.	——	——	X	——	X	X]
Electrical						
a. Power available to unit disconnect.	——	——	——	——	X	——
b. Power available to electric heating coil.	——	——	——	——	X	——
c. Proper motor rotation verified.	——	——	——	——	X	X
Controls						
a. Control valves properly installed.	——	——	X	——	——	——
b. Control valves operable.	——	——	X	——	X	——
Test and Balance (T&B)						
a. Test and Balance Report submitted.	——	——	X	——	——	X

15. PRE-COMMISSIONING CHECKLIST - EXHAUST FAN

For Exhaust Fan:_____ [fill in exhaust fan symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
1. Installation						
a. Fan belt adjusted.	——	——	X	——	——	X
2. Electrical						
a. Power available to fan disconnect.	——	——	——	——	X	——
b. Proper motor rotation verified.	——	——	——	——	——	X
Controls						
a. Control interlocks properly installed.	——	——	——	——	X	——
b. Control interlocks operable.	——	——	——	——	X	——
c. Dampers/actuators properly installed.	——	——	X	——	——	——
d. Dampers/actuators operable.	——	——	X	——	——	——
Test and Balance (T&B)						
a. T&B results +/- 10% cfm shown on drawings.	——	——	X	——	——	X
b. Test and Balance Report submitted.	——	——	X	——	——	X

16. PRE-COMMISSIONING CHECKLIST - COMPUTER ROOM UNIT

For Computer Room Unit:_____ [fill in computer room unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
1. Installation						
a. Unit properly supported.	——	——	X	——	X	X
b. Access doors are operable and sealed.	——	——	X	——	——	X
c. Casing undamaged.	——	——	X	——	X	X
d. Insulation undamaged.	——	——	X	——	X	X
e. Condensate drainage is unobstructed and routed to floor drain.	——	——	X	——	X	X
f. Fan belt adjusted.	——	——	X	——	——	X
Electrical						
a. Power available to unit disconnect.	——	——	——	——	X	X
b. Proper motor rotation verified.	——	——	——	——	——	X
c. Proper motor rotation verified.	——	——	——	——	——	X
[d. Power available to reheat coils.	——	——	——	——	——	X]
Coils/Humidifier						
a. Chilled water piping properly connected.	——	——	X	——	——	——
b. Chilled water piping pressure tested.	——	——	X	——	X	X
[a. Refrigerant piping properly connected.	——	——	X	——	X	X]
[b. Refrigerant piping pressure tested.	——	——	X	——	X	X]
c. Hot water piping properly connected.	——	——	X	——	——	——
d. Hot water piping pressure tested.	——	——	X	——	X	X
e. Steam piping properly connected.	——	——	X	——	X	——
f. Steam piping pressure tested.	——	——	X	——	X	X
g. Humidifier makeup water connected.	——	——	X	——	X	X

16. PRE-COMMISSIONING CHECKLIST - COMPUTER ROOM UNIT

For Computer Room Unit:_____ [fill in computer room unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Controls						
a. Control valves operable.	——	——	X	——	X	——
b. Unit control system operable and verified.	——	——	——	——	X	——
Test and Balance (T&B)						
a. Construction filters removed and replaced.	——	——	X	——	——	X
b. T&B simulate 1/2 loaded filters.	——	——	X	——	——	——
c. T&B results +/- 10% cfm shown on drawings.	——	——	X	——	——	X
d. Test and Balance Report submitted.	——	——	X	——	——	X

17. PRE-COMMISSIONING CHECKLIST - HVAC SYSTEM CONTROLS

For HVAC System:_____ [fill in system description]

CHECKLIST ITEM	A	B	C	D	E	F
1. Installation						
a. Layout of control panel matches drawings.	——	——	X	——	X	——
b. Framed instructions mounted in or near control panel.	——	——	X	——	X	——
c. Components properly labeled (on inside and outside of panel).	——	——	X	——	X	——
d. Control components piped and/or wired to labeled terminal strip(s).	——	——	X	——	X	——
e. EMCS connection made to labeled terminal strip(s) as shown on drawings.	——	——	X	——	X	——
f. Control wiring and tubing labeled at all terminations, splices, and junctions.	——	——	X	——	X	——
g. Shielded wiring used on electronic sensors.	——	——	X	——	X	——
Main Power and Control Air						
a. 110 volt AC power available to panel.	——	——	——	——	X	——
b. 20 psig compressed air available to panel.	——	——	X	——	X	——

18. PRE-COMMISSIONING CHECKLIST - SINGLE ZONE AIR HANDLING UNIT

For Air Handling Unit:_____ [fill in air handling unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Vibration isolation devices installed.	——	——	X	——	X	X
b. Access doors are operable and sealed.	——	——	X	——	——	X
c. Casing undamaged.	——	——	X	——	X	X
d. Insulation undamaged.	——	——	X	——	X	X
e. Condensate drainage is unobstructed.	——	——	X	——	X	X
f. Fan belt adjusted.	——	——	X	——	——	X
Electrical						
a. Power available to unit disconnect.	——	——	——	——	X	X
b. Power available to unit control panel.	——	——	——	——	X	——
c. Power available to electric heating coil.	——	——	——	——	X	——
e. Proper motor rotation verified.	——	——	——	——	——	X
Coils						
a. Chilled water piping properly connected.	——	——	X	——	——	——
b. Chilled water piping pressure tested.	——	——	X	——	X	X
[a. Refrigerant piping properly connected.	——	——	X	——	X	X]
[b. Refrigerant piping pressure tested.	——	——	X	——	X	X]
c. Hot water piping properly connected.	——	——	X	——	——	——
d. Hot water piping pressure tested.	——	——	X	——	X	X
[c. Steam piping properly connected.	——	——	X	——	X	]
[d. Steam piping pressure tested.	——	——	X	——	X	X]

18. PRE-COMMISSIONING CHECKLIST - SINGLE ZONE AIR HANDLING UNIT

For Air Handling Unit:_____ [fill in air handling unit symbol used on drawings]

CHECKLIST ITEM	A	B	C	D	E	F
Controls						
a. Control valves/actuators properly installed.	___	___	X	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___
Test and Balance (T&B)						
a. Construction filters removed and replaced.	___	___	X	___	___	X
b. T&B simulate 1/2 loaded filters.	___	___	X	___	___	X
c. T&B results +/- 10% cfm shown on drawings.	___	___	X	___	___	X
d. Test and Balance Report submitted.	___	___	X	___	___	X

APPENDIX 2

FUNCTIONAL PERFORMANCE TEST CHECKLISTS

1. FUNCTIONAL PERFORMANCE TEST CHECKLIST - PUMPS

For Pump:_____[fill in pump symbol used on drawings]

1. Activate pump start using control system commands (all possible combinations, on/auto, etc.). ON_____ AUTO_____ OFF_____

   a. Verify pressure drop across strainer:

      STRAINER INLET PRESSURE _____psig
      STRAINER OUTLET PRESSURE_____psig

   b. Verify pump inlet/outlet pressure reading, compare to Test and Balance report, pump design conditions, and pump manufacturer's performance .

	DESIGN	T&B	F.P.T.
PUMP INLET PRESSURE (psig)	_____	_____	_____
PUMP OUTLET PRESSURE (psig)	_____	_____	_____

   c. Operate pump at shut-off, 50% and 100% of scheduled flow. Plot test readings on pump curve.

	SHUT-OFF	50%	100%
PUMP INLET PRESSURE (psig)	_____	_____	_____
PUMP OUTLET PRESSURE (psig)	_____	_____	_____
PUMP FLOWRATE (gpm)	_____	_____	_____

2. Verify motor amperage each phase and voltage phase to phase and phase to ground.

	PHASE 1	PHASE 2	PHASE 3
AMPERAGE	_____	_____	_____
VOLTAGE		_____	_____
VOLTAGE		_____	
VOLTAGE TO GROUND	_____	_____	_____

3. Check and report unusual vibration, noise, etc.

   _____
   _____

4. Results:

a. Contractor shall record and submit results obtained in items 1 and 2 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

1. FUNCTIONAL PERFORMANCE TEST CHECKLIST - PUMPS

5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

2. FUNCTIONAL PERFORMANCE TEST CHECKLIST - CENTRIFUGAL CHILLER

For Chiller:_____ [fill in chiller symbol used on drawings]

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows:

a. Time of day start-up program initiates chiller start:

b. Start condenser water pump and establish condenser water flow. Verify chiller condenser water proof of flow switch operation:

c. Start chilled water pump and establish chilled water flow. Verify chiller chilled water proof of flow switch operation.

d. Verify control system energizes chiller start sequence:

e. Verify chiller senses chilled water temperature above set point and control system activates chiller start:

f. Verify functioning of "soft start" sequence:

g. Shut-off air handling equipment to remove load on chilled water system. Verify chiller shut down sequence is initiated and accomplished after load is removed:

h. Re-start air handling equipment 1 minute after chiller shut down. Verify condenser water pump, cooling tower and chiller restart sequence:

2. Results:

a. Contractor shall record and submit results obtained in item 1 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.:

DATE:_____

General Contractor’s Representative _____

Mechanical Contractor’s Representative _____

Electrical Contractor’s Representative _____

Balancing Contractor’s Representative _____

Controls Contractor’s Representative _____

Contracting Officer’s Representative _____

Engineering Division’s Representative _____

Air Force’s Representative _____

3. FUNCTIONAL PERFORMANCE TEST CHECKLIST - COOLING TOWER

For Cooling Tower:_____ [fill in cooling tower symbol used on drawings]

1. Functional Performance Test:_____Contractor shall demonstrate operation of the cooling tower as per specification and the following:

a. Activate cooling tower fan start using control system command. This should first start condenser water pump, establish flow, delay fan start, as specified, to equalize flow in distribution basin and sump. Verify fan start after timed delay:_____

b. After chiller start-up, control system should modulate bypass valve [and two-speed fan motor] to maintain condenser water setpoint. Verify function of bypass valve under varying loads: _____

c. Verify cooling tower interlock with chiller:_____

d. Verify make-up water float valve is functioning:_____ Activate chemical treatment feed valve, verify make-up of chemical treatment system, pump, and controls:_____

2. Results:

a. Contractor shall record and submit results obtained in item 1 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications:

DATE:_____

General Contractor’s Representative _____

Mechanical Contractor’s Representative _____

Electrical Contractor’s Representative _____

Balancing Contractor’s Representative _____

Controls Contractor’s Representative _____

Contracting Officer’s Representative _____

Engineering Division’s Representative _____

Air Force’s Representative _____

4. FUNCTIONAL PERFORMANCE TEST CHECKLIST - VAV TERMINALS

The Contracting Officer will select VAV terminals to be spot-checked during the functional performance test. The number of terminals shall not exceed 10.

1. Functional Performance Test: Contractor shall demonstrate operation of selected VAV boxes as per specifications including the following:

a. Cooling only VAV boxes:

(1) Verify VAV box response to room temperature setpoint adjustment. Changes to be cooling setpoint to cooling setpoint minus 10 degrees and return to cooling setpoint.

(2) Check damper maximum/minimum flow settings.

MAXIMUM FLOW SETTING _____cfm
MINIMUM FLOW SETTING _____cfm

b. Cooling/reheat VAV boxes:

(1) Verify VAV box response to room temperature setpoint adjustment. Changes to be cooling setpoint to heating setpoint and return to cooling setpoint.

(2) Check damper maximum/minimum flow settings.

MAXIMUM FLOW SETTING _____cfm
MINIMUM FLOW SETTING _____cfm

(3) Verify reheat coil operation.

c. Fan powered VAV boxes:

(1) Verify VAV box response to sensor call for heating via setpoint adjustment. Changes to be cooling setpoint to heating setpoint and return to cooling setpoint._____ Verify cooling damper closes to minimum position, blower fan energizes according to sequence of operation, and upon further drop in space temperature, heating coil activation and deactivation._____

(2) Check primary air damper maximum/minimum flow settings.

MAXIMUM FLOW SETTING _____cfm
MINIMUM FLOW SETTING _____cfm

(3) Check blower fan cfm._____ cfm

(4) Verify free operation of fan backdraft damper.

4. FUNCTIONAL PERFORMANCE TEST CHECKLIST - VAV TERMINALS

2. Results:

a. Contractor shall record and submit results obtained in item 1 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

5. FUNCTIONAL PERFORMANCE TEST CHECKLIST - VARIABLE VOLUME AIR HANDLING UNIT

For Air Handling Unit:_____[fill in air handling unit symbol used on drawings]

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. Verify activation of air handling unit using control system command.

ON_____ AUTO_____ OFF_____

b. The following sequence of control shall be verified during start-up:

1) All dampers in normal position._____

2) All valves in normal position._____

3) System safeties allow start if safety conditions are met. _____

4) VAV fan controller shall "soft-start" fan._____

c. Normal day-time operation - Economizer De-energized.

1) Outside air damper at minimum position._____

2) Return air damper open._____

3) Relief air damper closed._____

4) Chilled water control valve modulating to maintain leaving air temperature setpoint._____

5) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure setpoint._____

d. Normal day-time operation -Economizer Energized.

1) Outside air damper modulated to maintain mixed air temperature setpoint._____

2) Relief air damper modulates with outside air damper according to sequence of operation._____

3) Chilled water control valve modulating to maintain leaving air temperature setpoint._____

4) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure setpoint._____

e. Unoccupied mode

1) All dampers in normal position._____

2) Verify space low limit protection operation as specified in sequence of operation._____

f. System shut down

1) All dampers in normal position._____

2) All valves in normal position._____

3) Fan de-energizes._____

g. Verify chilled water coil control valve operation by varying supply air volume and recording supply air temperature at 40%, 80%, and 100% of design air volume.

	40%	80%	100%
SUPPLY AIR VOLUME (cfm)	_____	_____	_____
SUPPLY AIR TEMP. (F)	_____	_____	_____

h. Verify unit shut down during fire event initiated by smoke/heat sensors._____

i. Verify unit shut down due to freezestat._____

2. Results:

a. Contractor shall record and submit results obtained in item 1 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

6. FUNCTIONAL PERFORMANCE TEST CHECKLIST - SINGLE ZONE AIR HANDLING UNIT

For Air Handling Unit:_____ [fill in air handling unit symbol used on drawings]

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. Verify activation of air handling unit using control system command.

ON_____ AUTO_____ OFF_____

b. The following sequence of control shall be verified during start-up:

1) All dampers in normal position._____

2) All valves in normal position._____

3) System safeties allow start if safety conditions are met._____

c. Normal day-time operation - Economizer De-energized.

1) Outside air damper at minimum position._____
2) Return air damper open._____
3) Relief air damper closed._____
4) Chilled water control valve modulating to maintain space cooling temperature setpoint._____
5) Hot water control valve modulating to maintain space heating temperature setpoint._____

d. Normal day-time operation - Economizer Energized.

1) Outside air damper modulated to maintain mixed air temperature setpoint._____
2) Relief air damper modulates with outside air damper according to sequence of operation._____
3) Chilled water control valve modulating to maintain space cooling temperature setpoint._____

e. Unoccupied mode

1) All dampers in normal position._____
2) Verify space low limit protection operation as specified in sequence of operation._____

f. System shut down

1) All dampers in normal position._____
2) All valves in normal position._____
3) Fan de-energizes._____

g. Verify cooling coil and heating coil operation by varying thermostat setpoint from cooling setpoint to heating setpoint and returning to cooling setpoint._____

h. Verify unit shut down during fire event initiated by smoke/heat sensors._____

i. Verify unit shut down due to freezestat._____

2. Results:

a. Contractor shall record and submit results obtained in item 1 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

7. FUNCTIONAL PERFORMANCE TEST CHECKLIST - MULTI-ZONE AIR HANDLING UNIT

For Air Handling Unit:_____ [fill in air handling unit symbol used on drawings]

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. Verify activation of air handling unit using control system command.

ON_____ AUTO_____ OFF_____

b. The following sequence of control shall be verified during start-up:

1) All dampers in normal position._____
2) All valves in normal position._____
3) System safeties allow start if safety conditions are met._____

c. Normal day-time operation - Economizer De-energized.

1) Outside air damper at minimum position._____
2) Return air damper open._____
3) Relief air damper closed._____
4) Chilled water control valve modulating to maintain cold deck supply air temperature setpoint._____
5) Hot water control valve modulating to maintain hot deck supply air temperature setpoint._____

d. Normal day-time operation - Economizer Energized.

1) Outside air damper modulates to maintain mixed air temperature setpoint._____
2) Relief air damper modulates with outside air damper according to sequence of operation._____
3) Chilled water control valve modulating to maintain cold deck supply air temperature setpoint._____
4) Hot water control valve modulating to maintain hot deck supply air temperature setpoint._____

e. Unoccupied mode

1) All dampers in normal position._____
2) Verify space low limit protection operation as specified in sequence of operation._____

f. System shut down

1) All dampers in normal position._____
2) All valves in normal position._____
3) Fan de-energizes._____

g. Verify zone damper operation by varying zone thermostat setpoints from cooling setpoint to heating setpoint and returning to cooling setpoint._____

h. Verify unit shut down during fire event initiated by smoke/heat sensors._____

i. Verify unit shut down due to freezestat._____

2. Results:

a. Contractor shall record and submit results obtained in item 1 above to the contracting officer.

b. If specified equipment performance is not verified,, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

8. FUNCTIONAL PERFORMANCE TEST CHECKLIST - PACKAGED AIR COOLED CHILLER

For Chiller:_____[fill in chiller symbol used on drawings]

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows.

a. Start chilled water pump and establish chilled water flow. Verify chiller-chilled water proof of flow switch operation._____

b. Verify control system energizes chiller start sequence._____

c. Verify chiller senses chilled water temperature above set point and control system activates chiller start._____

d. Verify functioning of "soft start" sequence._____

e. Shut-off air handling equipment to remove load on chilled water system. Verify chiller shut down sequence is initiated and accomplished after load is removed._____

f. Re-start air handling equipment 1 minute after chiller shut down. Verify chiller restart sequence._____

2. Verify chiller inlet/outlet pressure reading, compare to Test and Balance Report, chiller design conditions, and chiller manufacturer's performance data.

	DESIGN	T&B	F.P.T.
CHILLER INLET PRESSURE (psig)	_____	_____	_____
CHILLER OUTLET PRESSURE psig)	_____	_____	_____

3. Verify chiller amperage each phase and voltage phase to phase and phase to ground.

	PHASE 1	PHASE 2	PHASE 3
AMPERAGE	_____	_____	_____
VOLTAGE		_____	_____
VOLTAGE		_____	
VOLTAGE TO GROUND	_____	_____	_____

4. Record the following information:

AMBIENT TEMPERATURE_____F.
ENTERING CHILLED WATER TEMPERATURE_____F.
LEAVING CHILLED WATER TEMPERATURE_____F.

5. Check and report unusual vibration, noise, etc.

_____
_____

6. Results:

a. Contractor shall record and submit results obtained in items 1, 2, 3, and 4 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test

7. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

9. FUNCTIONAL PERFORMANCE TEST CHECKLIST - AIR COOLED CONDENSING UNIT

For Condensing Unit:_____[fill in condensing unit symbol used on drawings]

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system as per specifications including the following: Start building air handler to provide load for condensing unit. Activate controls system start sequence as follows.

a. Start Air Handling Unit. Verify control system energizes condensing unit start sequence._____

b. Shut-off air handling equipment to verify condensing unit de-energizes._____

c. Re-start air handling equipment 1 minute after condensing unit shut down. Verify condensing unit restart sequence._____

2. Verify condensing unit amperage each phase and voltage phase to phase and phase to ground.

	PHASE 1	PHASE 2	PHASE 3
AMPERAGE	_____	_____	_____
VOLTAGE	_____	_____	
VOLTAGE	_____		
VOLTAGE TO GROUND	_____	_____	_____

3. Record the following information:

AMBIENT TEMPERATURE xxxxxx F.

4. Check and report unusual vibration, noise, etc.

_____

_____

5. Results:

a. Contractor shall record and submit results obtained in items 1, 2, 3, and 4 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

10. FUNCTIONAL PERFORMANCE TEST CHECKLIST - HOT WATER BOILER

For Boiler:_____[fill in boiler symbol used on drawings]

1. Functional Performance Test: Contractor shall demonstrate operation of hot water system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.

a. Start hot water pump and establish hot water flow. Verify boiler hot water proof of flow switch operation._____

b. Verify control system energizes boiler start sequence._____

c. Verify boiler senses hot water temperature below set point and control system activates boiler start._____

d. Shut-off building heating equipment to remove load on hot water system. Verify boiler shut down sequence is initiated and accomplished after load is removed._____

2. a) Verify boiler inlet/outlet pressure reading, compare to Test and Balance Report, boiler design conditions, and boiler manufacturer's performance data.

	DESIGN	T&B	F.P.T.
BOILER INLET PRESSURE (psig)	_____	_____	_____
BOILER OUTLET PRESSURE (psig)	_____	_____	_____
BOILER FLOWRATE (gpm)	_____	_____	_____

3. Record the following information:

AMBIENT TEMPERATURE_____F.
ENTERING HOT WATER TEMPERATURE_____F.
LEAVING HOT WATER TEMPERATURE_____F.

4. Check and report unusual vibration, noise, etc.

_____
_____

5. Results:

a. Contractor shall record and submit results obtained in items 1, 2, 3, and 4 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

11. FUNCTIONAL PERFORMANCE TEST CHECKLIST - STEAM BOILER

For Boiler: _____[fill in boiler symbol used on drawings]

1. Functional Performance Test: Contractor shall demonstrate operation of steam heating system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.

a. Start steam heating system. Verify control system energizes boiler start sequence._____

b. Verify boiler senses steam pressure below set point and control system activates boiler start._____

c. Shut-off building heating equipment to remove load on steam heating system. Verify boiler shut down sequence is initiated and accomplished after load is removed._____

2. Verify boiler inlet/outlet pressure reading, compare to boiler design conditions and manufacturer's performance data.

	DESIGN	F.P.T.
BOILER INLET WATER TEMP (F)	_____	_____
BOILER OUTLET PRESSURE (psig)	_____	_____

3. Record the following information:

AMBIENT TEMPERATURE_____F.

4. Check and report unusual vibration, noise, etc.

_____

_____

5. Results:

a. Contractor shall record and submit results obtained in items 1, 2, 3, and 4 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

11. FUNCTIONAL PERFORMANCE TEST CHECKLIST - STEAM BOILER

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

12. FUNCTIONAL PERFORMANCE TEST CHECKLIST - FAN COIL UNITS

The contracting officer will select fan coil units to be spot-checked during the functional performance test. The number of units shall not exceed 10.

1. Functional Performance Test: Contractor shall demonstrate operation of selected fan coils as per specifications including the following:

a. Cooling only fan coils:

1) Verify fan coil unit response to room temperature setpoint adjustment. Changes to be cooling setpoint to cooling setpoint minus 10 degrees and return to cooling setpoint._____

2) Check blower fan cfm._____cfm

3) Check inlet air temperature._____ F

4) Check outlet air temperature._____F

b. Cooling/heating fan coils:

1) Verify fan coil unit response to room temperature setpoint adjustment. Changes to be cooling setpoint to heating setpoint and return to cooling setpoint._____

3) Check blower fan cfm._____cfm

4) Check cooling mode inlet air temperature._____F

5) Check cooling mode outlet air temperature._____F

6) Check heating mode inlet air temperature._____F

7) Check heating mode outlet air temperature._____F

2. Results:

a. Contractor shall record and submit results obtained in item 1 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

12. FUNCTIONAL PERFORMANCE TEST CHECKLIST - FAN COIL UNITS

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

13. FUNCTIONAL PERFORMANCE TEST CHECKLIST - UNIT HEATERS

The Contracting Officer will select unit heaters to be spot-checked during the functional performance test. The number of units shall not exceed 10.

1. Functional Performance Test: Contractor shall demonstrate operation of selected unit heaters as per specifications including the following:

a) Verify unit heater response to room temperature setpoint adjustment. Changes to be heating setpoint to heating setpoint minus 10 degrees and return to heating setpoint.

b) Check blower fan cfm._____cfm

c) Check heating mode inlet air temperature._____F

d) Check heating mode outlet air temperature._____F

2. Results:

a. Contractor shall record and submit results obtained in item 1 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

14. FUNCTIONAL PERFORMANCE TEST CHECKLIST - STEAM/HOT WATER CONVERTER

For Converter:_____[fill in converter symbol used on drawings]

1. Functional Performance Test: Contractor shall demonstrate operation of heating system as per specifications including the following: Start building heating equipment to provide load for converter.

a. Verify control system energizes.

b. Verify converter senses hot water temperature below set point and control system modulates steam valve to compensate.

c. Shut-off building heating equipment to remove load on heating system. Verify converter steam valve closes after load is removed.

2. Verify converter inlet/outlet pressure reading, compare to converter design conditions and manufacturer's performance data.

	DESIGN	F.P.T.
CONVERTER INLET WATER TEMP (F)	_____	_____
CONVERTER OUTLET WATER TEMP (F)	_____	_____
CONVERTER INLET STEAM PRESSURE (psig)	_____	_____
CONVERTER WATER FLOWRATE (gpm)	_____	_____

3. Check and report unusual vibration, noise, etc.

_____

_____

4. Results:

a. Contractor shall record and submit results obtained in items 1, 2, and 3 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

14. FUNCTIONAL PERFORMANCE TEST CHECKLIST STEAM/HOT WATER CONVERTER

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

15. FUNCTIONAL PERFORMANCE TEST CHECKLIST - COMPUTER ROOM UNIT

For Computer Room Unit:_____[fill in computer room unit symbol used on drawings]

1. Functional Performance Test: Contractor shall verify operation of computer room unit as per specification including the following:

a. System safeties allow start if safety conditions are met:_____

b. Verify cooling and heating operation by varying thermostat setpoint from space setpoint to space setpoint plus 10 degrees, and returning to space setpoint:_____.

c. Verify humidifier operation by varying humidistat setpoint from space setpoint to space setpoint plus 20% RH, and returning to space setpoint._____.

d. Verify unit shut down during fire event initiated by smoke/heat sensors:_____.

2. Results:

a. Contractor shall record and submit results obtained in item 1 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____

16. FUNCTIONAL PERFORMANCE TEST CHECKLIST - HVAC CONTROLS

The Contracting Officer will select HVAC control systems to undergo functional performance testing. The number of control panels shall not exceed 4.

For HVAC system:_____[fill in system description]

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:

a. Verify that controller is maintaining the setpoint by manually measuring the controlled variable with a thermometer, sling psychrometer, inclined manometer, etc.

b. Verify sensor/controller combination by manually measuring the controlled medium. Take readings from control panel display and compare readings taken manually. Record all readings.

SENSOR_____

MANUAL MEASUREMENT_____

PANEL READING VALUE_____

c. Verify system stability by changing the controller setpoint as follows:

1. Air Temperature - 10 degrees F
2. Water Temperature - 10 degrees F
3. Static Pressure - 10 percent of setpoint
4. Relative Humidity - 10 % (RH)

The control system shall be observed for 10 minutes after the change in setpoint. Instability or excessive hunting will be unacceptable.

d. Verify interlock with other HVAC controls.
e. Verify interlock with fire alarm control panel.
f. Verify interlock with EMCS.

2. Results:

a. Contractor shall record and submit results obtained in item 1 above to the contracting officer.

b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

16. FUNCTIONAL PERFORMANCE TEST CHECKLIST - HVAC CONTROLS

DATE:_____

General Contractor's Representative _____

Mechanical Contractor's Representative _____

Electrical Contractor's Representative _____

Balancing Contractor's Representative _____

Controls Contractor's Representative _____

Contracting Officer's Representative _____

Engineering Division's Representative _____

Air Force's Representative _____